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Synthesis Report on the CSTD Panels on National Capacity-building in Biotechnology

Report by the Secretary-General

Executive Summary

The Commission on Science and Technology for Development (CSTD), at its fourth session in May 1999, selected as the substantive theme for its inter-sessional period 1999-2001 "National capacity-building in biotechnology", with particular attention to agriculture and the agro-industry, health and the environment. The Commission's work programme during the period 1999-2001 has been carried out through three panels. These panels covered issues of national capacity-building, including human resources development through basic science education and research & development (R&D); the transfer, commercialization and diffusion of biotechnology; public awareness and participation in science policy making; bioethics, biosafety and biodiversity; and legal and regulatory issues. The findings and policy recommendations that have emerged from these panels are contained in the present report for consideration by the Commission at its fifth session. This report provides an overview of the outcome of the work of the three CSTD panels along with findings and recommendations.

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Abbreviations an Accronyms

CBD	Convention on Biological Diversity
CSTD	United Nations Commission on Science and Technology for Development
ECOSOC	United Nations Economic and Social Council
FAO	Food and Agriculture Organization
GM	genetically-modified
GMO	Genetically-modified organism
HGP	Human Genome Project
IARCs	International Agricultural Research Centres
ICGEB	International Centre for Genetic Engineering and Biotechnology
IPP	Intellectual property protection
IPRs	Intellectual Property Rights
IT	Information technology
LMO	Living modified organism
R&D	Research and development
TRIPS	Trade-Related Intellectual Property Rights
UPOV	Union for the Protection of Plant Varieties
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNU/INTECH	United Nations University / Institute of New Technologies
WHO	World Health Organization
WTO	World Trade Organization

Overview

1. Biotechnology is a key area of technology for the new millennium. It has an immense range of applications in agriculture, healthcare, food processing, environmental protection, mining and even nanoelectronics. The use of biotechnology can ultimately provide economic and social welfare benefits to farmers, healthcare services, industrialists and consumers. Furthermore, biotechnology can contribute both to the national economy, through increased production and decreased social costs and to an improved environment. On the other hand, developments in biotechnology over the past few decades have presented significant challenges for policy makers. Much of the technology has been developed by the private sector in industrialized countries, giving rise to concerns about both the appropriateness and the accessibility of the new technologies for developing countries. Some areas of biotechnology are characterized by scientific uncertainty concerning the potentially adverse long-term impacts on health and the environment. Finally, developments in genetics and the application of gene technologies have heightened ethical and socio-economic concerns. If, therefore, biotechnology is to contribute significantly to national objectives, developing countries must build capacity to select, acquire and develop appropriate biotechnologies and manage them in such a way as to avoid or minimize potential threats to health, the environment and socio-economic well being. Developed countries should assist developing countries and countries with economies in transition to implement appropriate biotechnology applications so as to avoid potential threats.

2. The panel members recognized that the process of technology transfer is complex and involves various approaches and mechanisms. In respect of biotechnology, it is clear that appropriate approaches and mechanisms for, technology transfer are needed, which take into account some of the key characteristics of the technologies: they are science-based, knowledge-intensive, and often proprietary. It was suggested that greater understanding of the process and mechanisms of technology transfer is needed, including the role of Intellectual Property Rights regimes in facilitating or constraining successful transfer. It was recommended that studies be undertaken which would enhance such understanding.

3. Building technical capacity to absorb, develop and utilize biotechnologies within developing countries and economies in transition was the focus of the first panel. A key point, which emerged early in the current programme, was that developing country governments often spread their scarce resources for science and technology too thinly across organizations, areas of technology, and areas of application. It is evident that few countries would be able to build capacity in all areas of biotechnology, and therefore mechanisms are needed to enable the most efficient use of existing resources and future allocated resources, in respect of addressing national needs. Two mechanisms were recommended. First, a national assessment of capacity needs is recommended in order to set priorities for biotechnology development, application and governance. Second, resources should be targeted at one or more national centres of excellence which could act as loci for technology acquisition and generation, information exchange, and training. However, it was also recognized during subsequent panels that a wide range of knowledge and expertise is needed to successfully develop and manage biotechnology. This range goes beyond the scientific disciplines most closely associated with biotechnology, and includes ecology, physiology, computer sciences, together with legal, techno-managerial and policy expertise.

4. The issue of biological safety was debated at length during the second panel. It was agreed that substantial capacity-building in all areas is needed to effectively manage scientific and socio-economic uncertainties and potential risks, and that this will be a difficult task for most developing countries and countries with economies in transition. Most countries that have so far developed biosafety regimes, have done so in response to national development and diffusion of biotechnology rather than to manage imported technologies. However, it was argued that even countries with limited domestic capacity must still protect against perceived risks from imported biotechnologies and their products. For these countries, implementation of the Cartagéna Protocol on Biosafety is a starting point for developing their regulatory regimes. The panels agreed that information exchange and cooperation between developing countries and economies in transition could lessen the burden on individual countries in developing regulatory regimes. Regional cooperation, especially in respect of shared ecosystems and regulatory harmonization, was recommended. It was further recommended that the CSTD could facilitate the exchange of knowledge and experiences at international level, actively seek out best practices in biosafety, and, from these activities, develop a regulatory model for dissemination. The problem of enforcing regulations, once developed, was discussed at some length. Developments in diagnostics kits might provide part of the solution in future, but nevertheless, enforcement is likely to be very costly.

5. Given the extensive demands on resources for capacity-building, it was not surprising for the panel to stress that little attention has so far been devoted to bioethics and public awareness initiatives in most developing countries. However, following the public backlash against some gene technologies in Europe, public concerns about new technologies need to be addressed, and accommodated in national policies. The panel on public awareness and public participation in science policy-making concluded that the current lack of public interest in, and knowledge about, biotechnology means that most participatory mechanisms used in Europe and elsewhere are not satisfactory and not yet viable in many developing countries. Public awareness needs to be built as a prerequisite for effective, and truly representative, participation in the policy-making process. The panel recommended that Governments, regional organizations, NGOs and the international community take a constructive role in disseminating biotechnology-related information to the public. However, it was recognized that only through incentives would the scientific community become more active providers of balanced scientific information to the public and that the mass media has to be the main conduit for such information. Training in science communication, for both scientists and journalists, and facilitating closer relationships between scientist and journalists were recommended for action for governments and international organizations.

6. Over the course of the three panels, several critical systemic barriers to successful biotechnology development and management emerged. Training across a broad range of disciplines and areas of expertise was one of these. The other key areas identified were information management, institutional structures and linkages, and national policy regimes. Each of these will require more effective networks between various "stakeholder" groups, including policy-makers, scientists, the private sector, NGOs, the international community, and the general public. Policy regimes for science and technology, and biotechnology in particular, need to be integrated both with existing national and sectoral policies, and with the needs of industry and consumers. The panels concluded that successful policy formulation is, therefore, likely to be based on consensus-building between various stakeholder groups. Institutional linkages are key factors in successful diffusion of information, knowledge and

end-products of technology. The building up of partnerships and networks, between stakeholder groups at national, regional and international levels, can therefore make a significant contribution to biotechnology development.

7. Some of the recommendations presented by the panels for consideration by the CSTD focus on activities that address the above key issues. It is recommended that governments undertake national technology assessments to identify priority needs and assess existing capacity to meet these needs. Perhaps as part of this process, governments should be able to identify one or more institutions at national level to act as biotechnology focal points, centres of information dissemination and expertise, and as loci for training, and dialogue between stakeholder groups. Identifying regional institutions to fulfil a similar role is likely to be more difficult. It was also recommended that the CSTD, in cooperation with UNCTAD should set up a mechanism, such as a committee made up of a few members to mobilize extra-budgetary resources in order to undertake further study and information searches into key policy issues such as technology transfer, Intellectual Property Rights, and biosafety. The committee would be expected to collate, synthesize and disseminate information on best practices and regulatory models for the benefit of developing countries and countries with economies in transition.

1. INTRODUCTION

8. The characteristics of modern biotechnology provide both opportunities and challenges for developing countries. The new technologies have a wide range of potential applications, and many are knowledge rather than capital intensive. If countries are able to build capacity in their national innovation system, biotechnology has the potential to support national efforts towards food security, improved healthcare, increased export potential, and environmental sustainability. On the other hand, modern biotechnology is associated with uncertain impacts on health and the environment, and has also raised some socio-economic and ethical concerns.

9. The programme of the CSTD was intended to facilitate the development of policy recommendations and initiatives which could help build capacity in developing countries, both to take advantage of the opportunities presented by modern biotechnology and to minimize or overcome possible risks associated with it. The CSTD panels identified many issues of common concern, including training, the provision of facilities, technology transfer, regulation and public awareness. The panels found that key requirements for successful capacity-building include a wide range of training needs, better access to information, appropriate and flexible institutional arrangements and linkages and coherent policy regimes. To address these needs, recommendations were made for future action by the CSTD and also for initiatives at international, regional and national levels.

1.1 Background

10. The CSTD, at its fourth session in May 1999, selected as the substantive theme for its inter-sessional period 1999-2001 "National capacity-building in biotechnology", with particular attention to agriculture and the agro-industry, health and the environment. The Commission's work programme during the period 1999-2001 has been carried out through three panels, which have addressed the sub-themes as contained in resolution 1999/61 adopted by the United Nations Economic and Social Council (ECOSOC) at its meeting in July 1999. The sub-themes cover issues of national capacity-building, including human resources development through basic science education and research & development (R&D); the transfer, commercialization and diffusion of biotechnology; public awareness and participation in science policy making; bioethics, biosafety and biodiversity; and legal and regulatory issues. The findings and policy recommendations that have emerged from these panels are contained in the present report for consideration by the Commission at its fifth session.

11. In deciding the sub-themes to be addressed by the three panels, the Bureau of the Commission emphasized that the CSTD should play a more visible role as a catalyst, particularly in raising public awareness about the risks and benefits associated with biotechnology. It was also stressed that reaping the benefits of biotechnology while at the same time lowering its risks requires that capacity is built to: generate scientific knowledge; develop appropriate governance regimes, laws and regulations; raise public awareness; and facilitate dialogue among the scientific community, policy makers, industry and the public at large. It was also underscored that many countries do not have the capacity to make choices and regulate biotechnology and lack resources to develop and diffuse biotechnology. The CSTD should help these countries identify key steps and priorities to build their own capacity

for developing biotechnology and assuring its safety, assessing impacts and ensuring that developing countries' scientists are connected to the work of their peers.

12. A key objective in seeking answers to some of the challenges facing biotechnology is to provide forums for consultations, dialogue and exchange of views and ideas between scientists and science policy makers at different levels. To this end, it was suggested that members of the Commission themselves prepare country reports or solicit papers from their national biotechnology experts and scientists that would contribute to enhancing the work of the panels. Some of these papers were subsequently presented at the various panels. The present report provides a concise description of the outcome of the following three panels:

1.1.1 Capacity-building in biotechnology

13. The purpose of this panel was to identify key steps and priorities for developing countries and countries with economies in transition to build their own indigenous capacity to:

- Monitor and assess the impact of biotechnology applications and assure their safety;
- Manage and regulate biotechnology;
- Generate knowledge for the development of biotechnology by developing human resources through interdisciplinary education, training and research.

14. This identified a number of areas of core capacities and addressed a wide range of issues, including facilitating information-sharing, identifying problems and setting priorities, monitoring and assessment, compliance with biosafety standards and managing and regulating biotechnology.

1.1.2 Legal and regulatory issues in biotechnology

15. This panel addressed intellectual property protection systems, discussed legal and regulatory issues in biotechnology and examined aspects related to biosafety and other matters relevant to the transfer and diffusion of biotechnology in agriculture, nutrition, health and the environment.

16. In this panel, biosafety regulation generated the most discussion. This was because many developing countries are now at some stage in the process of developing or starting to implement national biosafety regimes, to deal among other things, with the Cartagena Protocol on Biosafety. Many countries actually began to identify significant gaps in building capacity during this process. Gaps include lack of expertise in risk assessment of biotechnology products; technical barriers to monitoring genetically modified organisms; and the costs of enforcing biosafety regulations, particularly in the case of transgenic crops.

17. Access to information on biotechnology which is freely available on the Internet also emerged as a major issue. This was seen as a positive way to facilitate technology transfer, particularly in respect of genome sequences, including those from the Human Genome Project. These genome databases and in fact the whole area of bioinformatics, open up opportunities for developing country scientists to innovate even with few resources.

1.1.3 Public awareness and participation in science policy-making in biotechnology

18. The main objective of this panel was to create a process for building public awareness and dialogue among scientists, the biotechnology industry, policy makers and the public on the potential benefits and possible risks of biotechnology.

19. This panel addressed ways and means to create a transparent process for building public awareness and dialogue among proponents and opponents of biotechnology (e.g. scientists, the biotechnology industry, policy makers and the public) on the potential benefits and hazards of biotechnology. The panel also discussed institutional arrangements needed to address and manage concerns associated with biotechnology.

1.2 Biotechnology: Opportunities and Challenges

20. Biotechnology is emerging as an important force in the global technology market. It encompasses a wide range of techniques, many of which provide opportunities for developing countries to become significant players in this market and to address local needs of food security, improved healthcare, and environmental sustainability. On the other hand, advancements in biotechnology over the past few decades have been characterized by a great deal of scientific uncertainty. Gene technologies have also raised new socio-economic and ethical concerns. The first and second panels highlighted the potential benefits and possible risks to developing countries.

1.2.1 Opportunities

21. In agriculture and the agro-industry, biotechnology could facilitate the development of improved crops and new products and contribute toward better livestock production. Potential benefits include:

- Increased yields through new varieties with increased tolerance to stress (such as pests, diseases, herbicides, poor soil quality, climate);
- Higher nutritional content;
- Reduced post-harvest losses;
- Reduced chemical inputs, leading to both financial savings and environmental benefits;
- Reduced livestock loss through early disease diagnosis, vaccination, and improved quality of animal feed, leading to better quality (and more marketable) livestock products;
- Wider opportunities for the development of agro-industrial products, leading to increased options for farmers to diversify their economic base.

22. Applications of biotechnology, both directly and indirectly, benefit environmental sustainability in the following ways:

- By increasing yields, and reducing losses, less forest land will need to be converted for agricultural use in future;

- Pest and disease resistant crops will reduce the use of chemical inputs and change some existing farming practices which now lead to soil degradation and erosion:
- Contribute to conservation of biodiversity through the use of new cellular and molecular tools to conserve, characterize and utilize plant collections more efficiently.

23. Developments in biotechnology have provided opportunities for improved disease diagnosis and more rapid development of vaccines and therapeutic drugs. Most of these developments have taken place in industrialized countries, however, the production of these developments can be produced at lower-cost in a number of developing countries such as India and South Africa. The panels recognized the importance of the work on the human genome to the future treatment of genetic diseases and the opportunities emerging knowledge provides for developing countries. The Human Genome Project (HGP) has uncovered and will continue to uncover a tremendous amount of new information, which may provide opportunities for new therapies, new drugs and new understandings of how humans function. Genome technologies and the transfer of those technologies between countries, has tremendously boosted the detection of disease genes. Further, the development of pharmocogenomics[1] is likely to become very significant for healthcare in developing countries in the future, where the expected benefits include more effective drugs and prevention of over-treatment or ineffective use of drugs.

24. Further, developments in genomics have provided vast amounts of public knowledge, much of it freely available on the Internet, which could be utilized by developing country scientists.

1.2.2 Risks and Uncertainties

25. Whilst recognizing that biotechnology is likely to play an increasingly important role in economic development and human welfare, the panels also accepted that biotechnology is characterized by scientific uncertainty and has presented new socio-economic, political and ethical threats. The meetings highlighted the main concerns for developing countries in respect of human health, environmental sustainability and socio-economic welfare.

26. Key risks that are directly associated with the application of gene technologies concern the impact of genetically modified crops on the environment and the potential impacts on human health from genetically modified food products. In respect of health, the risks were identified as:

- Introduction into food products of previously unknown allergens, or toxicity in novel food products and processes;
- Potentially adverse impacts of residual antibiotic marker genes in food. Even more uncertainty surrounds the environmental safety of genetically modified crops, particularly in respect of:
- Potential adverse impacts on non-target organisms;

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[1] Pharmocogenomics is a relatively new and rapidly progressing area, which combines pharmocology (concerned with drug dosages) and genomics, which is providing critical new knowledge about individuals' metabolization of specific drugs.

- Development of resistant pests, diseases and weeds;
- Loss of genetic crop diversity, leading to future possible increases in crop vulnerability to pests and diseases.

27. Some of the major potential socio-economic problems identified, particularly concerning the introduction of new GM crop varieties, were:

- New technologies which are not appropriate to developing country needs;
- Loss of markets that ban or avoid transgenic crops;
- Reduced competition in input supply resulting in fewer choices or higher prices for farmers;
- Inequity of distribution of benefits, where farmers who cannot afford the new genetically-modified crop varieties are further marginalized;
- Ownership issues related to intellectual property rights, especially where "broad patents" effectively close down areas of opportunity for developing country research;
- Public fears about the introduction of new technology and its applications.

28. These risks are not inherent in the technologies, but rather are associated with the way the technologies are taken up and applied. This, therefore, needs careful consideration and management.

1.2.3 Policy Challenges

29. For developing countries and countries with economies in transition, the fundamental challenge is to find ways and means to harness the potential benefits of the biotechnology knowledge base in support of national needs, whilst at the same time managing and minimizing the potential risks and uncertainties associated with the application of this knowledge. Common issues of concern to most countries were discussed. These included improving food security, increasing crop productivity, conserving biodiversity, reducing pest management costs, building institutional capacity for risk assessment, accessing information and developing human resources.

30. The panel members identified a number of major obstacles to biotechnology development that are common in most developing countries. These were inadequate financial resources, shortage of skilled manpower, poor infrastructure, difficulty in obtaining necessary equipment, and lack of clear strategies to advance the use of modern biotechnology. Barriers to the successful management of biotechnology include the lack of public awareness over potential benefits and possible risks of biotechnology applications and the lack of capacity to monitor and assess as well as manage and regulate biotechnology. Also, intellectual property management was considered to pose a difficult challenge for many countries as a number of them do not have regulatory systems in place.

31. In summary, it was agreed that policy makers need to take a holistic approach to capacity-building for biotechnology. Capacity is needed to access and monitor information on new techniques and applications, to acquire, absorb, adapt, develop and manage appropriate biotechnologies. This will require a wide range of scientific, techno-managerial and legal expertise. New institutional arrangements may be needed, with linkages and partnerships

being particularly important. Most biotechnology capacity in developing countries is located in universities and public research institutes: the private sector in developing countries needs to be encouraged to actively engage with the new technologies. Furthermore, there is a need to monitor new developments and inform the public.

2. NATIONAL CAPACITY-BUILDING

32. From country reports, it was clear that few countries have as yet developed comprehensive policy regimes targeted at biotechnology development. Others, such as Colombia, have already established national biosafety/biotechnology commissions to oversee biotechnology development and applications. It was recognized that developing countries and countries with economies in transition present an extremely diverse set of socio-economic and political contexts and represented widely-varying stages of technological development. However, the panels addressed issues that are likely to be of common concern to most countries. These were categorized as:

- Technical capacity needs: how to identify priority needs for resource allocation and build up centres of expertise in biotechnology;
- Regulatory mechanisms, particularly intellectual property rights and biosafety regimes, but also, mechanisms which facilitate the acquisition of new technologies;
- Public awareness, perceptions and participation in decision-making.

33. The following sections outline the highlights of the panels' discussions and conclusions.

2.1 National Assessments of Capacity Needs

34. A long-term integrated policy approach is needed to build capacity for biotechnology. This means reviewing and harmonizing policies in education, science and technology, health, agriculture and other key sectors. Furthermore, policy and legal capacity needs to be developed to address problems of technology transfer, intellectual property rights and regulatory regimes relating to biotechnology. Building comprehensive capabilities across all these areas is impossible for most developing countries.

35. Many developing countries, particularly those of Africa, tend to spread their limited financial and human resources across biotechnology sectors and research agencies. While many have recognized the importance of setting biotechnology priorities and concentrating resources in selected programmes, areas of application and/or institutions, many more continue to operate research programmes in an ad hoc way, within isolated, competing and often scientifically weak research organizations.

36. When considering developing countries that have made significant advances in developing scientific capacity to engage in biotechnology development, such as Argentina, Brazil, Colombia, India, the Islamic Republic of Iran, the Republic of Korea, Mexico and South Africa, the following observations were made:

- Most of the very substantial investments in capacity-building, including resources for coordination, management and oversight of capacity-building programmes, have come from national government budgets;
- As a result, even the larger countries have selectively targeted areas of biotechnology and their application, for capacity-building.

37. There is a perceived need in most developing countries to utilize existing capacity more effectively and establish priority needs in respect of future resource allocation. In carrying out a "capacity needs assessment", even countries with a low capacity in biotechnology could bring together the relevant stakeholders – including policy makers, regulators, the scientific community and the private sector – to plan for efficient use of scarce resources that is commensurate with national needs and to identify key institutions which might become focal points or centres of excellence. It was reported that these types of assessments are currently being carried out in several countries in sub-Saharan Africa.[2]

2.2 Centres of Excellence

38. There are a growing number of national centres of excellence in developing countries that are utilizing and developing advanced biotechnologies, particularly in Latin America and Asia. Some of these centres are dedicated to biotechnology, but more often the centre is more specifically mandated to carry out R&D in a particular sector (usually agriculture) or a specific area of agricultural application. Some institutions have been founded as centres of excellence, others have been built up by targeting established institutions in which to concentrate existing and additional resources for biotechnology. The financial resources needed to build capacity in these centres has mainly come from national Governments and other national public agencies. Occasionally, a national centre has been nominated as a regional centre of excellence[3] and this has opened up opportunities for international funding.

39. However, there are still few regional centres of excellence for biotechnology in the South. Regional centres could act as loci for information dissemination and regional dialogue and cooperation in biotechnology development and management. Nevertheless, one single institution could not contain all the various types of knowledge, expertise and technologies which might be desirable within a whole region. Therefore, it is likely that several centres of excellence would be needed at the regional level. Identifying and establishing sustainable funding mechanisms for suitable institutions and locations might be problematic.

40. Nevertheless, the CSTD panel agreed that work should commence to identify existing and potential centres of excellence, both at regional and national levels, which could take on roles as focal points for regional networks and perhaps undertake some training activities. They could, at least, act as a 'first port of call' for scientific and regulatory advice. Some of the international agricultural research centres (IARCs), together with regional and national centres of excellence in both industrialized countries and countries with economies in transition, could support capacity building efforts in less developed regions.

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[2] One project involves assessments in several east and southern African countries, undertaken by the African Centre for Technology Studies, Nairobi. Another is being undertaken in Ghana under the auspices of the Ministry of Environment, Science & Technology, which is funded by the Department for International Development (DFID), UK.

[3] This is the case for the Agricultural Biotechnology Centre in Hungary.

2.3 Technology Transfer and Diffusion

41. Two aspects of technology transfer are important. The first is the international transfer of technology, usually from industrialized to developing countries. The second is the diffusion of technology, both imported and locally developed, from the importing or innovating organization into the wider economy. The effectiveness of the various mechanisms of and incentives for, technology transfer are still not sufficiently clear, despite many years of study on this issue. In fact, country reports to the CSTD panels highlighted the problem of a lack of systematic understanding of the process of technology transfer and diffusion at the national level. Many countries reported that biotechnology is being developed primarily in the public sector research system. Transfers through private enterprises were few and generally involved more mature technologies such as tissue culture and fermentation techniques.

42. It was pointed out that the traditional "pipeline model" of technology transfer and policies associated with it, had often resulted in a great deal of technological failure in respect of contributing to development objectives. This model assumes that new technologies developed in the north are eventually transferred to developing countries mostly through foreign direct investment, where the technologies are then automatically absorbed and diffused in the receiving country. However, it has become evident that building capacity to absorb, diffuse and maintain new technologies is far more complex and costly than this linear model suggests.

43. Adherence to the model has tended to highlight problems of financing the initial acquisition of proprietary technology. On the other hand, taking a new approach to technological capacity-building reveals both enormous opportunities, and some alternative policy issues to be addressed. For example, a great deal of biotechnology-related knowledge is already in the public domain and therefore freely available to anyone who can access it. Accessing this knowledge is a key problem to be addressed. It is worthy to mention that the CSTD has in 1993 recommended the facilitation of such access to information through the Internet. Country reports to the CSTD indicated that such knowledge transfer is often effected through north-south collaborative research partnerships involving universities and public sector research institutes. Universities can therefore play a key role in the take-up, utilization and diffusion of new, publicly-available knowledge. However, there is a need to focus on what is really needed within the country. Collaborative research is often geared towards overseas donor agendas. Furthermore, a focus on overseas collaboration and competition for donor funding can undermine cooperation and networking between national research organizations and also between institutions from different countries in the south.

44. On a more positive note, some new approaches were suggested to overcome barriers to technology transfer. These included:

- Devising economic incentives to encourage local private sector participation in biotechnology development and seeking out opportunities for partnerships between the public sector and private sector (both at home and overseas);
- Finding ways to utilize the knowledge and skills of nationals based in other countries, perhaps through establishing networks and partnerships, in order to gain rather than lose from the perceived "brain drain";

- Focusing on mechanisms through which to access publicly-available biotechnology;
- Giving serious consideration to bioprospecting as a mechanism of technology transfer: this, it was pointed out, has not been fully explored, despite the original key objectives of the Convention on Biological Diversity (CBD).

45. The systemic nature of technological development must be recognized in order for initiatives to succeed. For example, providing access to Internet based information is relatively easy, but this will have little impact where the host institution is unable to pay the high on-going costs of Internet usage. To this end, it was stressed that as far back 1993, the CSTD has called for affordable access to the Internet. However, biotechnology does present developing countries with opportunities for technological leap-frogging, if the underlying barriers to successful technology transfer, including financial and legal measures and absorbtive capacity, are addressed.

2.4 Intellectual Property Rights

46. Some panel members felt that, as has been traditionally reasoned, that a strong intellectual property rights (IPRs) regime will encourage the inward transfer of technology, though in fact there is a shortage of empirical evidence to support this. It was argued that many statistics and case studies show that the role of IPRs regimes has been exaggerated with respect to technology transfer. It was noted that IPRs have often been seen as the major obstacle to technology transfer and this is particularly the case with more advanced technologies such as biotechnology. It was also pointed out that there are two arguments against this view, which are supported by evidence from those developing countries that have successfully entered into new areas of technology:

- Where national capacity exists to make use of proprietary knowledge, the capacity to negotiate and pay royalty fees also generally exists;
- With knowledge-intensive technologies like biotechnology, there is a huge amount of knowledge already in the public domain.

47. However, IPRs regimes are important in two respects. First, depending on the proprietary technology and its intended application in the receiving country, some firms are unwilling to transfer technologies to countries that cannot strictly enforce their proprietary rights through IPRs regimes, particularly patents. Second, when patents expire, the technology comprehensively described in the patent, passes into the public domain, which makes a national patent office a good source of scientific and technical knowledge.

48. Panel members pointed out that since the foundation of the World Trade Organization (WTO) and its associated international agreements, much of the policy debate about the role of IPRs systems in technology transfer has been superceded by the imperative to conform to WTO provisions on IPRs. For countries that are member States of the WTO, there is an obligation to implement the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Specific issues which relate to biotechnology include:

- The patenting of micro-organisms, and other living matter, especially human genes;

- IPRs for plants, either through membership of UPOV (Union for the Protection of Plant Varieties), or through a *sui generis* system[4].

49. Many developing countries have yet to decide their position on, or are firmly opposed to, IPRs for living matter. As the TRIPS Agreement stands, patents must be allowed for micro-organisms and in some industrialized countries the definition of micro-organism extends to sub-cellular material such as genes, gene sequences and plasmids.

50. Another area of contention is the adoption of the 1991 UPOV Convention to conform to the TRIPS requirement of IPRs for plants. It was noted that whilst many developing countries found the 1978 Convention acceptable, the revised Convention is not generally favoured. *Sui generis* systems of IPRs for plants have been developed in some countries, including India, South Africa and Nicaragua. However, these may be unacceptable to the WTO or some of its members states. The Convention on Biological Diversity has called for the WTO to recognize the importance of *sui generis* systems, though it has not been possible to come up with concrete guidelines at a global level for such systems.

51. Some panel members expressed concern that development of IPRs regimes in developing countries in order to conform to TRIPS may not provide sufficient benefits to those countries to justify the heavy resources expended. On a global scale, it was noted that only a small proportion of patents held world wide (4 per cent) are owned by developing country innovators, including those from newly industrialising countries. The associated costs of implementing TRIPS has made implementation very difficult, prompting most developing countries to request an extension beyond the January 2000 deadline. Several country reports to the CSTD Panel on Legal and Regulatory Issues in Biotechnology indicate that patent offices in many developing countries are under-staffed and poorly equipped to implement TRIPS, particularly in respect of advanced technologies such as biotechnology. Thorough patent searches are often impossible. Enforcement of IPRs is likely to be extremely difficult under these circumstances.

52. The issue of protecting traditional knowledge was discussed extensively. It was recognized that there are some inherent problems in respect of existing IPR regimes. Two characteristics of traditional knowledge are fundamentally incompatible with existing forms of IPRs. First, it is "traditional" – handed down across generations, rather than being newly generated and therefore, does not meet the innovative criteria of conventional IPRs regimes. Second, the knowledge is often held by, or on behalf of, communities, where conventional forms of IPRs confer legal rights on individuals. This perspective tends to favour the view that new forms of intellectual property protection (IPP) are needed to adequately protect traditional knowledge. An alternative view suggests that, before trying to develop an entirely new form of regulations, existing IPRs regimes should be exhaustively tested to see whether they may be suitable to protect traditional knowledge and/or genetic resources, at least in some aspects. It was noted that, currently, most arrangements which involve access to genetic resources and traditional knowledge are effected through simple contracts. This raises the question as to whether sui generis contracts already provide an adequately effective system.

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[4] *Sui generis* means "one of a kind". In this context, it therefore refers to a legislative or regulatory regime for protecting plants as intellectual property that is developed at national level, and that may be unique to that country. When reference is made to a *Sui generis* regime in the TRIPS Agreement (article 27.3.b), the expression is used in relation to the protection of plant varieties only.

53. Few panel members were able to report significant developments in their own countries in respect of intellectual property protection for traditional knowledge. In fact, many countries have first to undertake a substantial amount of research in order to fully assess their genetic resources and traditional knowledge associated with them. It was recognized that many organizations, including international agencies, are interested in the area of IPP for traditional knowledge, though the extent of their activities and progress was not clear. It was pointed out that the CBD had been actively working on the subject for several years, but was unable to report significant progress. Some panel members noted that, whilst there seem to be many international forums for debate, little practical development is actually taking place.

2.5 Biosafety and Bioethics

54. Country reports indicated that biosafety regimes have been, or are in the process of being, set up in many member countries, although evidence was presented to suggest that the majority of smaller developing countries had not yet formulated policies or regimes for biosafety.[5] Of those countries having introduced specific measures to manage biosafety, there are wide-ranging differences between them in terms of the scope of regulation, the approach taken (that is, the development of an entirely new regime, or building on existing regulations), the institutional arrangements and mandates for implementation and the types of regulatory mechanism used. Biosafety Committees or Commissions have been established in many countries to oversee implementation of national policies, although, with one or two exceptions, these Committees act in an advisory capacity only. Some countries having drafted biosafety regulations have not yet established institutional mechanisms for implementation.

55. Some key problems for enforcement of biosafety regulations and laws were highlighted. Several countries in Latin America have reported wide-scale illegal planting of transgenic crops. Diagnostic kits to identify such crops are in use in at least one of these countries. However, it was recognized that the costs of enforcement are likely to be high and regulatory agencies do not have sufficient capacity to handle some of the new technologies and their products. The concerns here include a lack of trained personnel and institutions and poor legal infrastructure, to assess and manage risks. It was noted that a wide range of scientific expertise is needed in order to develop enforceable regulations and procedures, including enhanced capacity in molecular biology, ecology and physiology. A major concern identified in developing risk assessment procedures is that they need to be ecosystem-specific. Lack of detailed knowledge about specific ecosystems will make effective risk assessment very difficult.

56. A question was raised concerning the appropriate timing for developing countries to formulate and implement national biosafety regulations, depending on their level of technological development. On the one hand, it was suggested that capacity-building in the use of biotechnology should precede the introduction of biosafety regimes, on the basis that there is little point expending resources to regulate technology which is not used in the country. This 'reactive' approach has been dominant in countries which are now advanced in biotechnology. The opposing argument is that biotechnology is developing very rapidly, whereas the development of biosafety regimes has been slow – this would favour a proactive

[5] For example, whilst some countries of the Latin American and Caribbean region have long-established regimes, it was reported that over 60 per cent of the region's countries have not yet built regimes.

approach to developing such regimes. Some members of the panel felt strongly that, where capacity to develop and manage biotechnology does not exist in some developing countries, there is still a need for biosafety regimes to manage potential risks from imports, legal or otherwise. It was noted that the spreading of genetically modified organisms (GMOs) also occurs through natural processes. Therefore, there is a need for a protection measures even in the absence of imports of GMOs.

57. From country reports presented, it was clear that in countries where regulations have already been developed, this has generally been done in response to domestic developments in biotechology, rather than in response to international concerns or in anticipation of future needs. For countries that have yet to introduce national competent authorities, and/or regulations and guidelines, implementation of the Cartatgena Protocol, the international agreement negotiated under the Convention on Biological Diversity to regulate international trade in Living Modified Organisms (LMOs), seems to be the starting point. Countries which are, or are preparing to become parties to the Cartagena Protocol on biosafety must be prepared to introduce institutional structures and procedures which are commensurate with terms and conditions of that agreement.

58. The development of risk assessment procedures under the Protocol is still being debated at the international level by signatory countries. Capacity to undertake such assessments is a major concern for many developing countries, although the terms of the Protocol state that the receiving country does not have to carry out the risk assessments themselves, but rather can require the exporter to undertake and pay for an independent assessment. However, it was pointed out that national regulations may need to go beyond implementation of the Cartagena Protocol. The Protocol is limited, in that it only covers transboundary movements of LMOs, not their release within national borders, and it only applies to some classes of LMOs.

59. The panel on Legal and Regulatory Issues in Biotechnology recognized that the Protocol raises concerns about apparent contradictions and inconsistencies which exist in international agreements. A key example of this problem is likely to be the application of the Cartagéna Protocol's Precautionary Principle to risk assessments. This principle holds that an absence or lack of scientific certainty about the potential risks of a technology cannot be used to justify claims that it is safe. In this case, the onus is on the technology exporting country to prove that the technology does not pose a life or health threat to human, animal or plant. On the other hand, WTO agreements that allow trade restrictions on the basis of protecting health and the environment put the onus on the importing country to justify such restrictions. It was pointed out that there are concerns that this inconsistency could lead to difficulties between technology exporting countries and importing countries.

60. Given some of the very complex and potentially costly requirements of formulating and implementing national biosafety regimes, the discussion turned to the role of the international community in assisting developing countries. It was cautioned that for too long, global discussions have focused more on trade in genetically modified commodities and less on trying to share experiences and expertise on national regulations and guidelines. One way in which it was suggested the costs of biosafety implementation could be kept down is through regional cooperation. It was pointed out that the Andean countries have developed a common pact on transboundary movement of GMOs, where different countries share some of

the same ecosystems. Regional pacts are also useful for the harmonization of biosafety standards between countries. To this end, it was emphasized that dissemination of best practices in regulations and guidelines, whether national or regional, would be very helpful to those countries seeking to establish legal and regulatory regimes. It is important to note that the United Nations Industrial Development Organization (UNIDO) is responsible for BINAS (the Biosafety Information Network and Advisory Services), which provides a comprehensive database of biosafety regulation, and information on field releases of GMOs in developing countries and countries with economies in transition. Such information can be found on-line at the BINAS web site (http://binas.unido.org/binas/).

61. Bearing in mind the lack of resources available, and the complexities of fulfilling both international obligations and meeting national needs, it was concluded that a two-pronged approach to biosafety may be appropriate: one short-term and the other long-term. The international community could organize training to facilitate both implementation of international regulations and build long-term capacity. At the same time, coordination and dissemination of national models for implementation would give more immediate assistance to those countries that have the least existing capacity to formulate biosafety regimes.

62. Going beyond issues of physical risk, it was clearly recognized that advances in biotechnology have raised, or increased, some moral and ethical concerns about the potential misuse of new technology. Many of the major fears about the potential of new genetic knowledge and the application of genetic engineering concern human health. However, bioethics is now also concerned with environmental ethics and with potentially adverse social and economic impacts of advanced biotechnologies, particularly regarding the introduction of genetically modified crops.

63. It was noted that the United Nations Educational, Scientific and Cultural Organization's International Council on Bioethics has urged all Governments to develop procedures for bioethics management.[6] None of the members of the Panel on Legal and Regulatory Issues in Biotechnology reported specific initiatives related to bioethics in their countries, though in some countries public awareness and public interest had been taken into account in the development of biosafety regimes more generally. In practice, the stakeholder community (that is, all those potentially affected by decisions made to promote or restrict a particular technology application) will reflect not only a wide variety of political, religious and cultural views, but also different levels of knowledge about the complex technologies concerned. This makes the issue of public awareness critically important.

2.6 Public Awareness and Participation in Science Policy-Making

64. At the first two CSTD panels on biotechnology, the need for greater public awareness and participation in decision-making regarding technology emerged as a significant issue for developing countries. The public concern against genetically modified products in some western European countries, strongly reinforced the need for a more transparent process of informing and involving non-experts in biotechnological development. One panel member pointed out, that although no commercial releases of GMOs have yet taken place in a number of developing countries, overseas anti-biotechnology groups are lobbying to oppose the

[6] UNESCO 1997, Article 16

development of gene technologies. As a result, it was felt that there is an urgent need to sensitize and objectively inform the public to some of the issues being raised in this way.

65. Increasing public acceptance of gene technology is a major incentive for national authorities and the scientific community. Therefore, it is essential investment be made in raising public awareness and involving the public in science policy-making. However, it was noted that in Europe for example, it seems that where the level of public awareness is relatively high, public acceptance of gene technology is not necessarily higher and is often lower than in countries with lower levels of awareness. This suggests that public awareness alone will not generate public acceptance of gene technology. Rather, the problem is one of awareness based on balanced, science-based information reaching the general public.

66. Even in industrialized countries, scientific literacy of the general public is considered to be very low, despite universal access to higher education, the mass media and other sources of information. For developing countries, with wide disparities in levels of education and access to information, the task of building greater scientific awareness will not be an easy one. To a large extent, this will depend on the ability and willingness of many different groups of people to improve information flows and engage in meaningful dialogue. Three key aspects of this communication process were identified as:

- The obligation of science to inform;
- The duty of the public to become informed;
- The appropriate role of journalists relative to science and the public.

67. Some government ministries have now initiated activities to provide such information, to balance the often adverse and scientifically inaccurate coverage of biotechnology in the mass media. Again, supply of balanced information has been found to be insufficient in raising awareness, particularly if it is not actively disseminated through channels routinely accessed by the public. Furthermore, it was noted that in some countries, the public does not always fully trust Government to provide unbiased scientific information.

68. Mass media participation is critical in raising public awareness. It was felt that journalists need to be responsible in their reporting of science news, but at the same time, it was recognized that the mass media's first priority is to provide "good stories" to the public, to increase circulation and attract advertisers. However, the quality of the scientific content of news stories could be improved if journalists receive training in science communication. It was recognized that there are not enough specialized science journalists in developing countries and science stories are rarely given prominence in the news. Also, there is evidence that science stories are often badly written, in terms of ease of reading. Better liaison with scientists is needed, but it may be up to the scientists themselves to initiate the building of such relationships.

69. Although there is a perceived need for scientists to become more directly active in raising public awareness with regard to their work, they are precluded from doing so for a number of reasons. First, the professional requirements of research, dissemination of research results and teaching of which scientists' careers depend, take up much of their time. Second, free discussion of their findings, particularly through the mass media, may be subject to institutional or funding agency restrictions, where intellectual property rights or other issues

force and demand secrecy. Third, scientists may not necessarily have the training or ability to communicate their work in "lay" terms to the general public. Therefore, mechanisms and incentives which enable and encourage scientists to widely communicate their results are needed.

70. In many developing countries where public awareness of science is low, public interest in science is also often low, limiting the potential success of activities to raise public awareness and to involve the public in science policy decision-making. As many countries do not have a universal education system and are burdened by language divisions, channels of mass communication often reach only a minority of the population, there are significant problems in respect of genuine public representation in national science policy. Nevertheless, various participatory mechanisms can still be useful for targeted stakeholder groups, or for local consultations. Further, the allocation of resources for mechanisms to involve the public in policy decisions is constrained by extremely limited public funds. Given this and where there is also a perceived lack of public awareness and interest in science policy, it was agreed that public participation must be justified in terms of expected benefits against expenditures.

71. On the other hand, it was noted that public fears about new technology are easily and rapidly stimulated, as is evident in some countries in Europe, where anti-biotechnology interest groups have very successfully engaged the participation of the media in their campaigns. Therefore, countries where public awareness and concern are low at present cannot afford to be complacent. Although a difficult task is faced in encouraging public interest, a concerted effort must nevertheless be made.

3. KEY ISSUES

72. Several key systemic issues related to capacity-building emerged from the panel discussions, which are briefly outlined in this section. They include interdisciplinary education and training and the importance of centres of excellence in these processes; IPRs and the transfer of technology; biosafety and regulations, monitoring and assessment of biotechnology; public awareness; information management, institutional structures and networks and integrated policy regimes.

3.1 Training

73. A wide range of expertise needs to be implemented, in order to support successful development and management of biotechnology. Initially, it is necessary to train scientists in disciplines most closely related to "modern" biotechnology, such as molecular biology and biochemistry. Other scientific disciplines, such as ecology and plant physiology, together with computer sciences, including electronic information management are also critical, particularly in respect of biosafety. Furthermore, greater policy, legal and techno-managerial expertise must be incorporated in areas critical to biotechnology development such as intellectual property rights and technology transfer. Finally, education in other diverse areas ranging from philosophy to science journalism is needed in order to address ethical issues and appease public concerns surrounding the application of gene technologies.

74. Developing countries need to identify possible gaps in existing education programmes and where appropriate obtain or provide training such as through centres of excellence, at

national or regional levels. Some international organizations already provide courses directed at managing biotechnology. Notable amongst these is the International Centre for Genetic Engineering and Biotechnology (ICGEB), although this institution usually provides financial support for training representatives from its own member countries. The ICGEB, therefore, financially precludes some countries which are in the greatest need of training. It was agreed that international support for such countries is needed.

3.2 Information Management

75. It was recognized that better access to information and knowledge would greatly facilitate acquisition, development and diffusion of biotechnology, as well as the development of legal and regulatory frameworks to manage technologies. Objective information about biotechnology should be provided by academics, Governments and the mass media and disseminated to the general public in comprehensible terms.

76. In respect of building technical and scientific capacity, the following needs were highlighted for future attention:

- Providing greater access to electronic databases and other Internet-based information sources;
- Implementing mechanisms to select (from the huge volumes of available information on biotechnology) and disseminate information which is most relevant to capacity-building and policy formulation;
- Disseminating information in different languages;
- Building networks for sharing information and expertise.

77. The panels concluded that a crucial area for national capacity-building in respect of information flows was to facilitate access to new knowledge through promoting and establishing an information technology (IT) infrastructure. Access to the Internet is an increasingly important resource for technological development and programmes should be established–with international support where necessary–to improve such access. In particular, resources should be targeted at addressing some of the contextual problems of Internet access in developing countries. These include the high cost and low reliability, of telecommunications systems; the scarcity of web server facilities; problems of power supply and equipment failure; and, the unequal distribution of Internet access, where few facilities exist outside capital cities.

3.3 Institutional Structures and Linkages

78. Networks and collaborative research links were recognized as important mechanisms for information and knowledge transfer. It was recommended that national Governments enact policies to promote the establishment of such links. Furthermore, careful attention should be paid to ensuring that the most effective utilization is made of these links in respect of knowledge and information transfer. Therefore, policies should:

- Promote user-innovator networks, including links between industrialized and developing countries and links between the public and private sectors;

- Encourage collaborative research agreements which provide for equitable sharing of benefits, recognizing that such benefits should go beyond financial reward to include technology transfer;
- Ensure the allocation of resources to provide new knowledge and equally important to extend support to mechanisms to diffuse this knowledge through appropriate instruments, including global satellite networks.

79. At the level of individual institutions, it was noted that research institutes in particular might need to become more flexible to move into and invest in quite diverse areas of expertise. Advancements in biotechnology have brought about rapid technological changes in all sectors, particularly in agricultural research. New products very quickly displace existing products and processes. A classic example of this can occur when genetic engineering threatens to displace conventional plant breeding, which has its own set of techniques and skills built up over a long period. Such technological 'discontinuities' can lead to tension between the need to introduce new technology and the reluctance to abandon existing capacity in older technologies.

80. Finally, there is a need to enhance and develop "science diplomacy". There is an emerging belief that some of the resources expended on traditional diplomatic activities might be effectively used to forge partnerships with prominent institutions of higher learning and research.

3.4 Integrated Policy Regimes

81. Policy regimes for biotechnology need to be harmonized with and integrated into other sectoral policies. Moreover, they should also take into account the need to encourage private sector investment in technological development, as well as the concerns of the general public. This requires building relationships between Governments and many other stakeholder organizations and groups, including universities, research institutes, private firms, farmers and healthcare providers. In particular, policy-makers should encourage complementary roles for the public and private sector within the national R&D system. Policies should be a product of dialogue between these stakeholders and should rely on a continuous input of scientific expertise in order to reflect the rapidly-changing technical complexities associated with biotechnology development.

82. Furthermore, it should be recognized that building capacity for biotechnology development and management requires long-term commitment and planning. It was suggested that a key weakness in many developing countries is not so much the lack of expertise, but the inability to establish programmes for capacity-building and to sustain them over a long period.

4. CONCLUSIONS

83. Over the course of the three panels, several critical systemic barriers to successful biotechnology development and management emerged. Training across a broad range of disciplines and areas of expertise was a primary barrier. Other key barriers identified were information management, institutional structures and linkages and national policy regimes. In order to overcome these barriers, a more effective network between various 'stakeholder'

groups, including policy-makers, scientists, the private sector, NGOs, the international community and the general public is required. Therefore, there is a need for policy coherence. Specifically, policy regimes for science and technology and biotechnology need to be integrated both within existing national and sectoral policies, as well as within the needs of industry and consumers. The panels concluded that successful policy formulation is, therefore, likely to be based on consensus-building between various stakeholder groups. Institutional linkages will be key factors in the successful diffusion of information, knowledge and end-products of technology. The building-up of partnerships and networks, between stakeholder groups at national, regional and international levels, can therefore make a significant contribution to biotechnology development.

84. Recommendations put forward by the panels for consideration by the CSTD focus on activities which address the above key issues. It was recommended that Governments, in collaboration with the CSTD and UNCTAD, undertake national technology assessments to identify priority needs and assess existing capacity to meet these needs. Perhaps, as part of this process, Governments should identify one or more institutions at the national level to act as biotechnology focal points, centres of information dissemination and expertise and as loci for training and to promote dialogue between stakeholder groups. Identifying regional institutions to fulfil a similar role is likely to prove more difficult.

5. KEY RECOMMENDATIONS FOR THE CONSIDERATION OF THE CSTD

85. The three panels raised a number of issues that resulted in findings and recommendations to Governments and the international community in terms of policy options and needed initiatives and strategies for national capacity-building in biotechnology. The following are some of the recommendations:

5.1 National Technology Assessments

86. The CSTD, in collaboration with UNCTAD and other relevant United Nations agencies, should develop a methodology to undertake technology assessments or, "capacity needs assessments". This, in order to assist Governments of developing countries and countries with economies in transition build national strategies, coherent policy regimes and action plans, which address:

- Identifying priorities for capacity-building in the areas of food production, healthcare and the environment, including the conservation of biological resources;
- Formulating frameworks for the identifying, evaluating, acquiring, adaptating, developing and managing of biotechnology;
- Discerning information needs, particularly with respect to monitoring global developments in biotechnology;
- Generating knowledge via focal points, centers of excellence, IT networks, etc.

5.2 National Focal Points

87. National governments are invited to identify and communicate contact details of a national institution in order for the Commission to establish a network to coordinate activities relating to:

- Participation in and contribution to the UNCTAD network on Science and Technology for Development;
- Information collection and dissemination in respect of biotechnology developments, including policy and regulatory issues;
- Public awareness and public participation in science policy-making;
- Identification of centres of excellence in biotechnology.

88. These national bodies should be able to take responsibility for liaising with relevant organizations at the local level. At the international level, the CSTD should disseminate information via this newly established network of national coordinating bodies.

5.3 Models and Best Practices

89. Panel participants agreed that the CSTD is well-placed to serve as a catalyst in raising public awareness and improving public understanding of biotechnology-related issues such as food production and food safety. In this connection, the CSTD may wish to collaborate with relevant institutions to draw up guidelines for raising public awareness. These guidelines should be published in a succinct easy-to-read handbook, or possibly a "resource pack".[7] This resource pack could include balanced information on biotechnology and examples of mechanisms and appropriate institutional arrangements to educate the public and inform the media and policy-makers about biotechnology.

5.4 Technology series studies

90. UNCTAD should undertake studies which seek to provide, through empirical case studies, a better understanding of:

- The potential impact of TRIPS regimes on the transfer of technology including impact on technological development and diffusion of biotechnology;
- The role of information networks in technology transfer.

91. The CSTD may wish to consider whether a mechanism, such as the creation of a group made up of Commission members to ensure the implementation of its recommendations, including mobilization of extra-budgetary funds for their funding. The group would be expected to collate, synthesize, and disseminate information on best practices and regulatory models for the benefit of developing countries and countries with economies in transition. UNCTAD would serve such a group.

92. The key recommendations presented here, to the fifth Session of the CSTD, were formulated on the clear understanding that such recommendations could realistically be

[7] A small sample "resource pack" was distributed at the 3rd panel, for consideration.

implemented only if additional extra-budgetary resources are made available to the secretariat. It is recognized that mechanisms are needed to ensure follow-up actions are taken on approved recommendations wherever possible and that barriers to implementation are clearly identified and reported to subsequent sessions.

References

In addition to contributions from panel members, the following papers have been drawn upon for this report

Dr. John Mugabe (April 2000), African Centre for Technology Studies (ACTS), Kenya. "Biotechnology in developing countries and countries with economies in transition: strategic capacity building consideration"

Prof. Lynn Mytelka (April 2000), Carleton University, Canada. "Building capacity for biotechnology monitoring and assessment"

Dr. Peter Gregory (April 2000), Jellinek, Schwartz & Connolly Inc., USA. "Managing and regulating biotechnology in developing countries: key steps to building national capacity"

Prof. Calestous Juma (July 2000), Centre for International Development, Harvard University, USA. "Promoting biotechnology acquisition and development – the broad policy context"

Prof. Gert-Jan van Ommen (July 2000), University of Leiden, Netherlands. "The Human Genome Project: issues arising for technology transfer, Intellectual Property Rights, and bioethics"

Dr. Rodrigo Artunduaga Salas (July 2000), Colombian Agricultural Institute, Colombia. "Biosafety regulations related with transgenic plants in Latin America and the Caribbean region"

Prof. Richard Braun (November 2000), European Federation of Biotechnology Task Group on Public Perceptions of Biotechnology. "The Europeans' ambivalence about biotechnology: Possible ways forward"

Prof. Vladimír Báleš (November 2000), Dean, Faculty of Chemical Technology, Slovak University of Technology, Bratislava). "Biotechnology in science and in policy"
Mr. G. Essegbey (November 2000), Senior Scientific Officer, Science & Technology Policy Research Institute, Ghana). "Technology Assessment, stakeholder participation and public awareness: Experiences in a Developing Country Context"